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Some Behavioral Effects of Pre- and Neo-Natal Exposure to an ELF Rotating Magnetic Field

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INTRODUCTION

Rats that have been exposed during their prenatal development to an ELF (0.5 Hz) rotating magnetic field (RMF) with intensities ranging from < 1 to 30 gauss, have been reported to show decreased ambulatory behavior (Ossenkopp, 1972; Persinger, 1969), increased defecation (Persinger, 1969), less bar pressing during a Sidman avoidance situation (Persinger and Foster, 1970), and greater conditioned suppression (Persinger and Pear, 1972), relative to controls. Prenatally RMF-exposed rats also showed significant increases in thyroid and testicle weights (Ossenkopp, Koltek and Persinger, 1972). To further test the behavioral consequences of prenatal RMF exposure, we decided to use other operant techniques. Research with the Halasz procedure (delayed conditioned approach) has shown that rats with various brain lesions can be differentiated in situations where other more static procedures are relatively insensitive (e.g., Halasz, et al., 1970). A modified version of this procedure was used in the present studies.

METHOD

SUBJECTS. Sixteen sixty day old female Holtzman strain albino rats were used as subjects. Eight of the animals had been exposed during their fetal development to a 0.5 Hz rotating magnetic field (RMF) with intensities of either < 1-3 gauss (RMF-L group) or 3-30 gauss (RMF-H group). The other eight subjects had been exposed during their prenatal development to either a control or sham-RMF field.

APPARATUS. The RMF was created by two horseshoe magnets rotating in opposite direction about their major axes at 30 rot/min by an electric motor. More precise descriptions and a diagram of the apparatus have been published elsewhere (Persinger and Pear, 1972).

PROCEDURE. The breeding and exposure procedures for the mothers of the subjects used in this study have been described earlier (Ossenkopp et al., 1972; Persinger, 1969). Essentially, following exposure to the RMF with intensities of either 0.5-3 or 3-30 gauss during prenatal days 1 to 21 (birth), the animals and their mothers were removed from the experimental situation. Control subjects had spent their prenatal development in an area 200 cm from the closest magnet,

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while sham-subjects had spent their prenatal development in the apparatus which produced the RMF, but with the magnets removed. The latter procedure was implemented in order to control for possible artifactual stimuli from the apparatus. When the subjects had reached the testing age, they were trained under 23-hr water deprivation to press a lever for water reinforcement at the onset of a 24 s tone. There were 30 tone-water presentations per session and six sessions per week. When the animals had acquired the discrimination, a 10 s delay was instituted in a step-like fashion half-way through one session and maintained for the remaining sessions. During the 10 s delay no water was available.

RESULTS AND DISCUSSION

Figure 1 summarizes the ratio of total session responses over mean baseline total responses for baseline, step (⌐) and consequent days. As can be seen, the RMF-exposed rats (P1-21) emitted significantly more ($p < 0.01$) bar presses than either controls or sham animals when the 10 sec delay was introduced. An exposure intensity dependence was evident but not statistically significant.

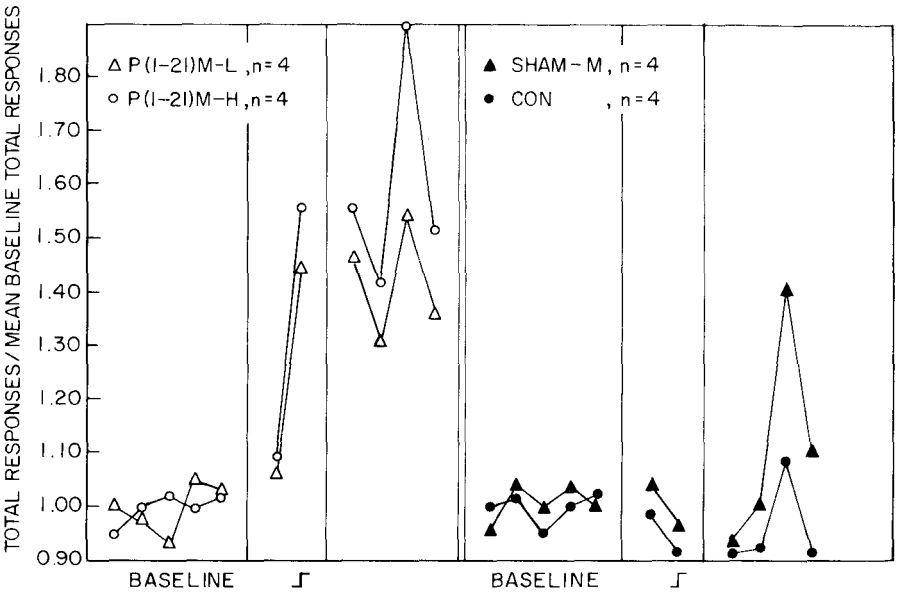

Fig. 1. Response rate changes following introduction of reinforcement delay (⌐) for rats that had been exposed during prenatal days 1-21 (birth) to a 0.5 Hz RMF-H (3-30 gauss), RMF-L (0.5-3 gauss), control and sham-field conditions.

The reliability of these findings is indicated since the observed behavioral effects showed both a RMF intensity-dependence and developmental-time dependence. This effect can be more clearly seen in Fig. 2. Results from both the present study and an unpublished doctoral dissertation (Persinger, 1971) indicate that responding to changes in conditioned tone-water reinforcement delivery varies with the time of prenatal or neonatal exposure to the RMF. Such behavior following the withdrawal of maintaining stimuli is popularly called "frustration".

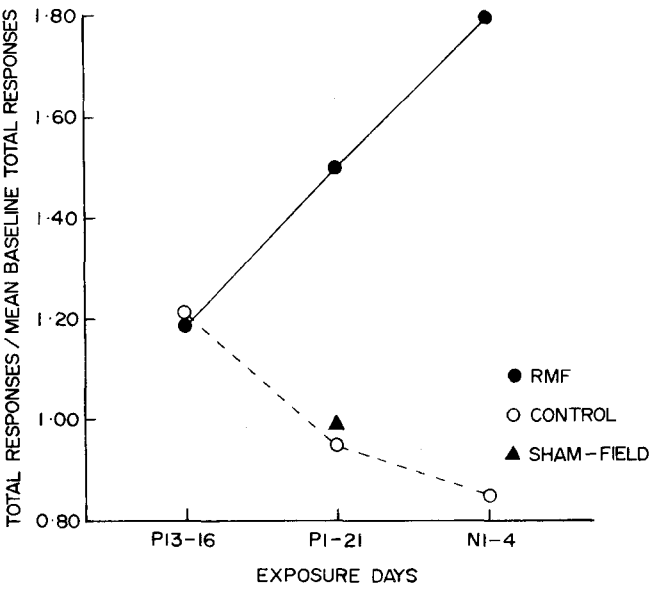

Fig. 2. Summary of response rate changes for adult rats that had been exposed to either RMF, control, or sham-field conditions during prenatal days 13-16 (P 13-16), prenatal days 1-21 (P 1-21), and neonatal (postnatal) days 1-4 (N 1-4).

The precise mechanism by which these effects are mediated remains to be isolated. Maturation changes of the cerebellum and thyroid-pituitary complex parallels the RMF effect and would certainly be implicated from the works of Ossenkopp, Koltek and Persinger (1972) and Ludwig (1971). However histological results of the cereballar cortices, ventral hypothalamic areas and thyroids of these animals are interesting but inconclusive to date.

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